

ANDEAN ORCHID CONSERVATION AND THE ROLE OF PRIVATE LANDS: A CASE STUDY FROM ECUADOR

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ABSTRACT. Orchids represent ca. 10% of the world's flowering plant species, and their diversity and endemism reach their maximum in the montane forests of the Andes. In Ecuador, nearly 80% of the 700 orchid species endemic to the country are found at 300–3000 m elevation. Microclimatic specialization and geographic isolation of elevational bands in montane regions have favored orchid speciation and the evolution of restricted-range species. With 75% of montane forests destroyed, and only 15% of species protected within existing reserves, fully a third of Ecuador's endemic orchid species are at risk of extinction. Private reserves in the Andes can play a major role in the conservation of orchids. After outlining existing legal mechanisms for conservation of habitat on private lands, we present a case study of the application of a conservation easement to the protection of the El Pahuma Orchid Reserve in the Ecuadorian Andes.

RESUMEN. Las orquídeas representan aproximadamente 10% de la flora mundial y su diversidad y endemismo máximo es en los bosques montanos de los Andes. En el Ecuador, casi 80% de las 700 especies endémicas al país se encuentran entre 300 y 3000 m. Especialización microclimática y aislamiento geográfico de los niveles de altura han favorecido la especiación y la evolución de especies de rangos restringidos. Con la destrucción de 75% de los bosques montanos y solo 15% de las especies protegidas en las reservas existentes, la tercera parte de las orquídeas endémicas del Ecuador están en peligro de extinción. Las reservas privadas en los Andes pueden tomar un rol importante para la conservación de orquídeas. En el presente, ofrecemos un perfil de los mecanismos legales existentes para conservar hábitats en tierras privadas y presentamos un estudio del caso de la aplicación de una servidumbre ecológica para la protección de la Reserva Orquideológica El Pahuma en los Andes del Ecuador.

Key words: orchids, endemism, Andes, conservation easement, El Pahuma, Ecuador

INTRODUCTION

For centuries, orchids have fascinated private collectors and public societies worldwide. Although these plants have been extensively studied, cultivated, and exhibited, only recently has protection of wild orchid habitat captured the attention of orchid enthusiasts. Tropical regions contain more than 50% of the Earth's biological diversity, including the majority of all orchid species. Habitat destruction in the tropics has placed countless species under threat of extinction, and protection of montane forests in particular is urgently needed, if orchid populations are to be saved. Here, we summarize patterns of orchid diversity and review why endemism and diversity peak in montane forests of the Andes. Making the case that private land can serve a major role in conserving tropical orchid diversity, we discuss various legal mechanisms for private lands protection. With a focus on conservation easements, we provide a case study of the El Pahuma Orchid Reserve in Ecuador.

Patterns of Orchid Diversity and Endemism

Although tropical lowland rain forests are widely recognized as great storehouses of bio-

diversity, they are closely rivaled by the montane forests of the Andes, which may harbor as much as half of South America's vascular plant species in only a tenth of the total land area (Kapelle & Brown 2001). In Ecuador, analysis of the distribution of a representative fraction of the country's flora found that 48% of species were restricted to elevations at 900–3000 m elevation (Balslev 1988), an altitudinal band constituting 10% of Ecuador's territory. The high biodiversity of middle elevations is largely the result of an increased abundance of epiphytes, which constitute ca. 10% of vascular plant species worldwide, with representatives in at least 84 families (Gentry & Dodson 1987).

Orchids are by far the most diverse family of vascular epiphytes, representing 22 of the 47 most speciose epiphytic genera in the world. Among all orchid species, 70% are epiphytic (Gentry & Dodson 1987, Dressler 1981). In Ecuador, recent estimates place the diversity of orchids at 220 genera and more than 3750 species, representing more than 10% of the country's vascular flora (C. Dodson, C. Luer & G. Romero unpubl. data). As with other epiphytes, orchid species richness in tropical America peaks in the Andean mountains at 1000–2000 m elevation (Ibisch et al. 1996, IUCN/SSC Orchid Specialist

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Group 1996). In Ecuador, nearly 3000 orchid species (77% of country total) are found at 300–3000 m elevation, with greater levels of diversity occurring on the western slopes (C. Dodson, C. Luer & G. Romero unpubl. data).

Tropical montane forests are considered to be rich in endemic species (Kruckeberg & Rabinowitz 1985, Balslev 1988, Olson & Dinerstein 1997), defined as those “confined to a single domain or to a few localities” (Kruckeberg & Rabinowitz 1985). Balslev (1988) showed that nearly 40% of a sample of Ecuador’s vascular flora occurring at middle elevations (900–3000 m) were endemic to the country. Furthermore, the western slopes of the Andes displayed considerably higher rates of endemism, possessing 56% of the middle-elevation endemic species as compared to only 31% on the eastern slopes. Borchsenius (1997) showed that the richest Ecuadorian endemic floras are found in the provinces of Pichincha (72 endemic species at 900–2000 m elevation and 93 endemic species at 2000–3000 m) and Loja (36 species at 900–2000 m elevation and 116 species at 2000–3000 m). Some 700 species of Ecuador’s orchids (19% of the country’s total) and seven genera are endemic to the country (C. Dodson et al. unpubl. data), and 70% of these occur in montane forests (Endara this issue).

Why Are Montane Forests So Diverse?

Gentry and Dodson (1987), summarizing the ideal habitat for epiphyte diversity as “wet, middle-elevation, rich-soil, tropical American forests,” showed that this growth form could make up nearly a quarter of total plant diversity in the Andes. The observation that many taxa reach their peak diversity and endemism at 1000–3000 m elevation is consistent with factors driving evolution and speciation in montane areas. Foremost among these is the great microclimatic variation found in mountainous regions. Elevation, aspect, and frequent intermediate-scale disturbance (e.g., treefalls, landslides) contribute to high variation in light, temperature, and moisture across small distances. Very fine niche partitioning (i.e., hyper-specialization on a narrow range of conditions, even within one tree) has been identified as a leading cause of high alpha diversity in orchids (Gentry & Dodson 1987, Jost 2003). Several examples of extreme epiphyte alpha diversity (Nieder et al. 1999) underscore the substantial contribution of this group to overall vascular plant diversity: In a single 175-m² plot in Cajanuma, Ecuador, Bøgh (1992) found 33 families of epiphytes; on a single tree in Venezuela, Longman (1917) counted 66 epiphytic species.

Montane forests also are characterized by high epiphyte beta diversity (Nieder et al. 1999, but see predictions in Kessler 2001), defined as species turnover rates within similar habitat. For example, two similar sites in Ecuador separated by only 30 km shared only 35% of their epiphytic species (Nieder et al. 1999). Geographic isolation of elevational bands separated by intervening valleys favors speciation and is mediated by limitation of pollinator movement. As a group, epiphytes are dominated by zoophilous pollination (Ackerman 1986), and the extreme topographic variation characteristic of montane regions may greatly reduce the mobility of insect pollinators and to a lesser extent avian pollinators. Both microclimatic specialization and geographic isolation have contributed to the small range sizes of many species and the evolution of high levels of endemism in montane areas. In addition to orchids, peaks in species richness and/or endemism at middle elevations have been found for animal taxa, such as leaf litter reptiles and amphibians (Scott 1976), insects (Janzen 1973, Janzen et al. 1976), and birds (Terborgh & Winter 1983).

Threats to Andean Orchids

Since the 1960s, increased population growth, economic development, and financial pressures have led to increased rates of deforestation throughout the Andes (Dirección General de Estadísticas y Censos 1960, World Bank 2000, Vanacker et al. 2003). Montane forests alone have been reduced to 25% of their former extent (Armenteras et al. 2003). Indeed, destruction and fragmentation of habitat is the leading threat to orchid biodiversity worldwide (IUCN/SSC Orchid Specialist Group 1996). The tropical Andes and western Ecuador (including the Chocó-Darién region) have been identified as two of the world’s 25 biodiversity “hotspots” (Brooks et al. 2002). These areas are suffering annual deforestation rates of 0.94% and 1.43% respectively (Food and Agriculture Organization 1997). Illegal extraction of orchids is the second major cause of decline in wild populations. Because of these and other threats, such as habitat degradation and climate change, one in three of Ecuador’s endemic orchid species are threatened (Endara this issue). Sadly, only 15% of threatened endemic orchids in Ecuador currently are protected under the existing system of parks and reserves.

METHODS

Role of Private Lands in Orchid Conservation

A question of critical importance to biologists concerns the minimum reserve size necessary to

achieve lasting conservation. The answer depends primarily on which organisms and ecological processes one is trying to conserve. In the lowland rain forests of tropical America, a reserve millions of ha in size still may be insufficient to protect viable populations of the largest predators such as jaguars (Terborgh 1999). In contrast, a narrow endemic species restricted to a single mountaintop may be well protected in a reserve of just a few hundred ha (Kessler 2001, Müller 2003).

Andean orchids are particularly well suited to conservation on private lands. High alpha diversity indicates that relatively small reserves will contain large numbers of species. High beta-diversity and high levels of endemism indicate that even neighboring reserves of similar habitat will protect a different set of species. Orchids, widely appreciated as they are, can be managed effectively in small areas by local people (IUCN/SSC Orchid Specialist Group 1996). Many species of orchids are well adapted to secondary or disturbed conditions and thus can survive in human-impacted forests. A network of small private reserves thus may be able to protect a substantial proportion of the total orchid diversity of the Andes. For many of the 85% of Ecuador's endemic orchids that fall outside of existing reserves and occur in the heavily populated and highly fragmented Andean landscape, small privately managed reserves may be the only remaining option to protect them in the wild.

Four hurdles must be overcome if conservation on private lands is to succeed. First, biodiversity mapping and gap analysis (Scott 1993) must continue to identify centers of orchid endemism that lack protection. Second, the minimum sustainable reserve sizes for various orchid taxa need to be determined by studying, for example, the range and population dynamics of their pollinators, minimum viable population sizes, and seed dispersal patterns. Third, because much of the montane forest habitat in the Andes is in private ownership, legal mechanisms for conservation on private lands must be evaluated, improved, and implemented. Finally, once reserves are created, mechanisms must be set in place to encourage revenue generation from sustainable, non-destructive sources. Such revenue will allow reserve owners to continue conserving their land and to regard protected habitat as a benefit to their lives rather than a limitation on their economic prosperity.

Legal Mechanisms for Conservation on Private Lands

Private lands conservation in the American tropics, while a recent undertaking, has had

many successes and is gaining in popularity. With the majority of tropical habitats outside of national parks held on private lands, legal mechanisms for their conservation rapidly are being strengthened, promoted, and executed. A recent overview by the Environmental Law Institute (2003) describes in detail the principal mechanisms employed for voluntary land conservation. These mechanisms include land purchase by NGOs (non-governmental organizations), formally declared private reserves, informal conservation agreements, land donations to government protected area systems, land trusts and limited development efforts, and conservation easements.

The benefits and shortcomings of each option must be considered before choosing the approach best suited to each case, when establishing some form of a private reserve. Land purchase, traditionally a favored technique, has the benefit of placing management control wholly in the hands of the conservation organization. Land purchase can be expensive, however, as rural landowners increasingly recognize the value of undisturbed habitat to international organizations. Additional expense is incurred by the financial demands for reserve management and protection. Furthermore, outright purchase often has the unintended effect of ostracizing members of the local community, who may look upon land purchase as an invasion of their domain by foreigners. Such attitudes routinely lead to much higher risks of poaching and illegal invasion, than if the land were to remain in local hands. Nonetheless, land purchase by NGOs has succeeded in protecting many hundreds of thousands of ha of habitat throughout the American tropics.

Private reserve designations exist in various forms throughout Latin American countries. Brazil has been the most successful in applying this approach, with nearly 500,000 ha protected as of 2002 (Environmental Law Institute 2003). Nearly as much land (400,000 ha) has been set aside in Chile in private protected-area networks. The total area of all private reserves in the orchid-rich countries of Colombia, Peru, and Ecuador, however, was only 253,000 ha as of 2003. Unfortunately, federal and state private reserves suffer from a number of shortcomings that weaken their utility as a long-term habitat protection tool. Foremost is that the lack of resources for monitoring and enforcement cause nearly all such reserves to quickly become so-called "paper parks," while logging, hunting, dumping, and other affronts continue unabated. Protected status may collapse at the whim of current administrators under economic or political pressure to develop land. Landowners also

may be reticent to participate in government-authorized programs because of a lack of trust or confidence, or because they believe they are forfeiting too many land-use rights for few demonstrable benefits.

Informal land protection agreements are widely used in the tropics, often as a stopgap measure, while more strict and binding mechanisms are negotiated and constituted. Informal agreements range from simple written contracts between landowners and conservation organizations to more precise contracts based on the civil code. Informal agreements are appealing to landowners because they are flexible, simple to enact, and are typically easy to terminate. For the latter reason, they are viewed as less than ideal land-protection mechanisms by conservation organizations. Nonetheless, they have been implemented in a large number of cases and have successfully achieved, at least in the short term, the desired goal of forestalling forest loss.

Conservation Easements in Latin America

Conservation easements, made popular in the United States during the past several decades, are growing in popularity in tropical America, and have been employed in a number of countries, most notably Costa Rica. A conservation easement is a voluntary agreement, in which the landowner agrees to limit the use of property, for some fixed term or in perpetuity, under the supervision of a second landowner, typically a conservation organization. The agreement is inscribed in the registry of deeds, and therefore remains in effect regardless of sale or other transfer of property title. The first conservation easement in the American tropics was signed in Costa Rica in 1992, and that country now has nearly 60 in effect; by 2002 at least 10 conservation easements had been enacted in Mexico and another 14 in Paraguay. Most of these easements have been for very small properties: in Costa Rica for example, the total land area protected under 57 separate easements was only 5500 ha (Environmental Law Institute 2003).

One of the major benefits of conservation easements is their low cost relative to land purchase. The easement signed to protect the El Pahuma Orchid Reserve (see Case Study, below) was enacted for less than \$2000 and was funded by a single donation from the San Diego County Orchid Society. In addition, the organization holding the easement only incurs costs of monitoring compliance (typically annually), rather than the far higher costs of reserve management required by outright land purchase. Easements also are appealing to landowners because of the flexibility available to both parties during draft-

ing of the agreement's clauses. The rights and responsibilities of each party can be tailored to suit the landowner's needs and the organization's objectives specific to each case.

Although easements are a well-established mechanism for land protection in the United States, their implementation in Latin America has been hampered by several limitations. First, no national laws recognize the use of traditional easements specifically for conservation purposes. Only appurtenant easements are recognized, a legal mechanism developed originally for such purposes as ensuring right-of-way access, and these have been adapted to conservation purposes. Several restrictions characteristic of appurtenant easements limit, however, their effectiveness for conservation, such as the requirement that the two participants must be neighboring landowners. Second, enforcement of easements can be tenuous, although of the two easement-litigation cases ever filed (in Mexico and Argentina), both were decided in favor of the local conservation organization. Litigation can be costly (ca. \$15,000 in the Mexico case), and organizations utilizing easements therefore must prepare financially for this possibility. Third, many landowners in tropical America lack clear title to their land, precluding the legal implementation of easements. Finally, the lack of built-in incentives for landowners to sign easements has slowed their adoption as a preferred conservation tool.

In the United States, property tax exemptions typically are awarded to landowners signing easements, an incentive that has proved powerful in recruiting prospective landowners. In Latin America, such tax waivers are non-existent and unlikely to be adopted because of the fiscal crises and hard currency shortages experienced by many tropical countries. Thus the development of alternative financial incentives or other types of incentives has become a major goal for groups promoting easements.

One widely used incentive is for conservation organizations to simply provide direct payments to landowners in exchange for easements. While often useful in helping to alleviate the financial impacts of restrictions on land use, direct payments do nothing to promote the adoption of more sustainable land-use practices. Development of infrastructure for tourism or other economic activities can provide an incentive that supports sustainable use of protected lands. In particular, this can be effective when combined with technical training and education aimed at providing the landowner and community members the capacity to create and manage sustainable alternatives for generating income. The Ceiba Foundation for Tropical Conservation

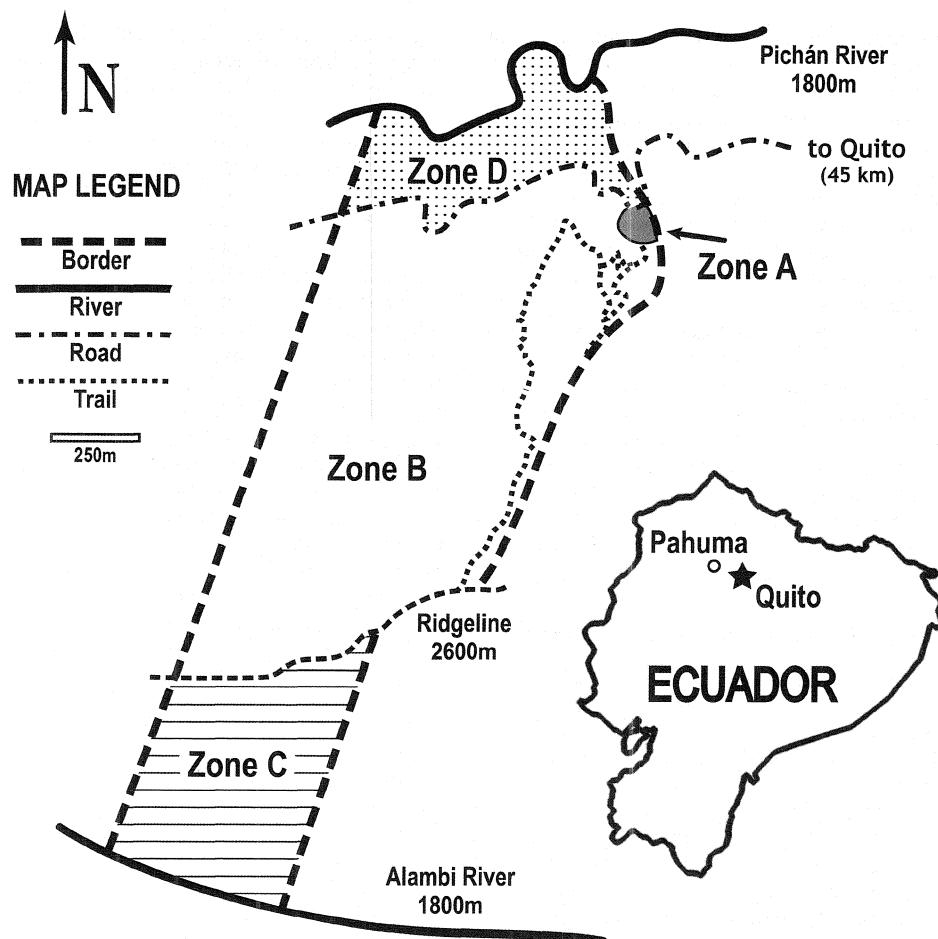


FIGURE 1. The El Pahuma Orchid Reserve, indicating zonation as specified in the conservation easement. Zone A = intensive use area containing nature center and botanical garden and permitting high visitation; Zone B = minimum impact area with limited visitation; Zone C = strict protection area closed to the public; Zone D = residence area for use by landowner.

(CFTC) is working to develop creative incentives, such as a program of college scholarships for children of landowners who commit to protect their lands. In all cases, as in the El Pahuma Orchid Reserve, the most effective incentives for conservation will be those that address the landowner's needs, while building capacity to manage resources sustainably.

EL PAHUMA ORCHID RESERVE, ECUADOR: A CASE STUDY

The El Pahuma Orchid Reserve protects 650 ha of montane forest in the Pichincha province of Ecuador, near the capital, Quito (FIGURE 1). Occupying an elevational range of 1800–2600 m on the western slopes of the Andes ($0^{\circ}01.5120'N$,

$78^{\circ}37.9402'W$), the reserve contains a diverse set of microclimates. The forest is classified as Very Moist Lower Montane with 2000–4500 mm of precipitation annually and average annual temperatures of 12–18°C. Rain falls year round, with the least precipitation in July and August (Cañas 1983).

Primary forest occupies ca. 575 ha, with the remaining made up of secondary forest and a small area of regenerating pasture. Forest, with a canopy 10–20 m in height, is dominated by *Croton magdalenensis* (Euphorbiaceae), *Clusia alata* (Clusiaceae), and *Blakea rotundifolia* (Melastomataceae) and blankets steep hillsides of 50–85% slope (Freire 2000). The ongoing inventory of orchids currently lists 187 taxa, some of which have yet to be identified to species.

TABLE 1. At the El Pahuma Orchid Reserve in Ecuador, 89 orchid species are identified to species, based on preliminary inventories made in 1999–2003 by P. Myers, M. Mites, C. Woodward, and C. Douglas, with assistance of others. An additional 97 species are in the process of being identified, many of them in the genera *Pleurothallis* and *Stelis*.

Orchid species at El Pahuma	Orchid species at El Pahuma
<i>Ada elegantula</i> (Rchb. f.) N. H. Williams	<i>Lycomormium ecuadorensis</i> Sweet
<i>Altensteinia virescens</i> Kunth	<i>Masdevallia angulata</i> Rchb. f.
<i>Anguloa virginalis</i> Lindl.	<i>Masdevallia bucculenta</i> Luer
<i>Bletia purpurea</i> (Lam.) DC.	<i>Masdevallia cucullata</i> Rchb. f.
<i>Brachtia andina</i> Rchb. f. & Lindl.	<i>Masdevallia nidifica</i> Rchb. f.
<i>Brassia arcuigera</i> Rchb. f.	<i>Masdevallia ophioglossa</i> Rchb. f.
<i>Chondrorhyncha embreei</i> Dodson & Neudecker	<i>Masdevallia ventricularia</i> Rchb. f.
<i>Comparettia falcata</i> Poepp. & Endl.	<i>Maxillaria acutifolia</i> Lindl.
<i>Cyrtochilum flexuosum</i> Kunth	<i>Maxillaria aurea</i> (Poepp. & Endl.) L. O. Williams
<i>Cyrtochilum macranthum</i> (Lindl.) Kraenzl.	<i>Maxillaria lehmannii</i> Rchb. f.
<i>Cyrtochilum meirax</i> Rchb. f.) Dalström	<i>Maxillaria lepidota</i> Lindl.
<i>Cyrtochilum serratum</i> (Lindl.) Kraenzl.	<i>Odontoglossum cirrhosum</i> Lindl.
<i>Cyrtochilum williamsianum</i> (Dodson) Dalström	<i>Odontoglossum cristatellum</i> Rchb. f.
<i>Dichaea longa</i> Schltr.	<i>Odontoglossum cristatum</i> Lindl.
<i>Dracula felix</i> (Luer) Luer	<i>Odontoglossum hallii</i> Lindl.
<i>Dracula hirtzii</i> Luer	<i>Oncidium abortivum</i> Rchb. f.
<i>Dracula navarroorum</i> Luer & Hirtz	<i>Oncidium cucullatum</i> Lindl.
<i>Dracula polyphemus</i> (Luer) Luer	<i>Oncidium heteranthum</i> Poepp. & Endl.
<i>Dracula sodiroi</i> (Schltr.) Luer	<i>Phragmipedium lindenii</i> Dressler. & N. Williams
<i>Dryadella hirtzii</i> Luer	<i>Pleurothallis anceps</i> Luer
<i>Elleanthus capitatus</i> (Poepp. & Endl.) Rchb. f.	<i>Pleurothallis cordata</i> (Ruiz & Pav.) Lindl.
<i>Elleanthus gastroglossis</i> Schltr.	<i>Pleurothallis cordifolia</i> Rchb. F. & W. Egner
<i>Elleanthus robustus</i> (Rchb. f.) Rchb. f.	<i>Pleurothallis deflexa</i> Luer
<i>Epidendrum cochlidioides</i> Lindl.	<i>Pleurothallis macra</i> Lindl.
<i>Epidendrum embreei</i> Dodson	<i>Pleurothallis ruberrima</i> Lindl.
<i>Epidendrum gastropodium</i> Rchb. f.	<i>Pleurothallis ruscifolia</i> (Jacq.) R. Br.
<i>Epidendrum geminiflorum</i> Kunth	<i>Porroglossum amethystinum</i> (Rchb. f.) Garay
<i>Epidendrum macrooiphorum</i> Hágsater & Dodson	<i>Porroglossum muscosum</i> (Rchb. f.) Schltr.
<i>Epidendrum mancum</i> Lindl.	<i>Prosthechea hartwegii</i> (Lindl.) W. E. Higgins
<i>Epidendrum porphyreum</i> Lindl.	<i>Prosthechea vespa</i> (Vell.) W. E. Higgins.
<i>Epidendrum quintensis</i> Rchb. f.	<i>Sobralia crocea</i> (Poepp. & Endl.) Rchb. f.
<i>Epidendrum sophronitoides</i> F. Lehmann & Kraenzl.	<i>Sobralia ecuadoriana</i> Dodson
<i>Epidendrum renilabium</i> Schltr.	<i>Stanhopea impressa</i> Rolfe
<i>Govenia sodiroi</i> Schltr.	<i>Stelis argentata</i> Lindl.
<i>Habenaria monorrhiza</i> (Sw.) Rchb. f.	<i>Stelis eublepharis</i> Rchb. F.
<i>Kefersteinia taurina</i> Rchb. f.	<i>Stelis flexuosa</i> Lindl.
<i>Lepanthes biloba</i> Lindl.	<i>Sympyglossum sanguineum</i> (Benth.) Schltr.
<i>Lepanthes gargantua</i> Rchb. f.	<i>Telipogon steinii</i> Dodson & R. Escobar
<i>Lepanthes mucronata</i> Lindl.	<i>Trichopilia fragrans</i> (Lindl.) Rchb. f.
<i>Lepanthes pecunialis</i> Luer & Hirtz	<i>Warrea warreana</i> (Lodd. ex Lindl.) C. Schw.
<i>Lepanthes stupenda</i> Luer	<i>Xylobium leontoglossum</i> (Rchb. f.) Rolfe
<i>Lockhartia choocoensis</i> Kraenzl	<i>Zootrophion dayanum</i> (Rchb. f.) Luer
<i>Lycaste ciliata</i> (Ruiz & Pav.) Lindl. ex Rchb. f.	<i>Zootrophion hirtzii</i> Luer
<i>Lycaste gigantea</i> Lindl.	<i>Zootrophion hypodiscus</i> (Rchb. f.) Luer

Selected species are shown in TABLE 1. Several plant species new to science found within the reserve are in the process of being identified, such as *Ruagea* sp. nov., *Cupania* sp. nov., *Myrcianthes* sp. nov., *Philodendron* sp. nov., *Cleome* sp. nov., and three Gesneriaceae (Freire 2000, T. Cochrane pers. comm., Clark 2003). In addition, the reserve provides habitat for a number of threatened or rare animal species, including the spectacled bear (*Tremarctos ornatus*), plate-billed mountain-toucan (*Andigena laminiros-*

tris), toucan barbet (*Semnornis ramphastinus*), and giant antpitta (*Grallaria gigantea*).

The Ceiba Foundation for Tropical Conservation first made acquaintance with the landowner, Efraín Lima, in early 1997 on a reconnaissance trip to Ecuador. Lima expressed his interest in conservation and his desire to draw paying visitors to his forest, rather than clearing the land for timber. After several meetings and site explorations to discuss the landowner's vision and to assess the conservation value of the

property, CFTC initiated negotiations for the implementation of a conservation easement. The education of the landowner regarding easements, the development of incentives and negotiation of terms, and the compilation of baseline documentation (boundary maps, photos of existing structures, inventories, etc.) were conducted during a 2-year period. Because this easement was the first of its kind in Ecuador, we anticipate that future easements may require less than one year to enact. The legal drafting, signing, notarization, and registration of the easement followed successfully in August 2000.

El Pahuma's Conservation Easement

The conservation easement at El Pahuma was created for the purposes of maintaining "the current extent and integrity of the primary and secondary forests" and protecting "populations of native plants and animals, especially native species of orchids and all species threatened with extinction" (translated from easement No. 2000-EC001, CFTC, August 2000, p. 2). The conservation strength of the easement is embodied in its fourth clause, "Prohibited Uses," which disallows "activities that expressly or implicitly diminish, intend to diminish or that negatively affect the purposes and objectives of this easement." Such disallowed activities include cutting of timber, hunting, extraction of plants or animals, construction of buildings, mining or excavation, livestock production, and contamination of air, soil and water. The easement divided the property into four zones each designated by allowable levels of use and impact within them (FIGURE 1), and required that specific management directives be outlined in a management plan. Among the rights retained by the landowner were the rights to inhabit the property (within Zone D) and to sell or transfer the property. CFTC acquired the obligation to create a management plan and to monitor the property for compliance with the easement terms. CFTC was granted the right of first purchase in the event of property sale and the right to prevent any activities that violate the easement.

The Ceiba Foundation for Tropical Conservation offered an incentive package that included the construction of basic tourism infrastructure (trails, signage, and a nature center), the installation of an orchid botanical garden, technical training to reserve staff and owners, and printing of promotional materials for the reserve. A small direct payment in the form of monthly "rental" of management rights also was made during the first year. This offer was effective in convincing the landowner to sign a strictly worded easement. The infrastructure develop-

ment established the basis for a sustainable source of ecotourism revenue to support the landowner and management of the reserve.

The value of all incentives given in exchange for the 25-year easement, combined with the legal costs of constituting the easement itself, totaled ca. \$50,000. By contrast, the purchase of the same property at an estimated 2000 market price of \$400 per hectare would have cost \$260,000. The conservation easement therefore constituted a substantial savings compared to land purchase and represents an economical alternative for habitat protection. Furthermore, the indirect benefits derived from empowering local people to control and manage their own natural resources in a sustainable manner, while deriving sufficient income from these activities, are substantial.

The Ceiba Foundation for Tropical Conservation also has sponsored the development of an environmental education program at El Pahuma, in fulfillment of the organization's obligations specified in the easement. The program is designed to educate school groups and day visitors to the reserve regarding the value of montane forests, the threats such forests face, and some of the essential ecological services they provide (e.g., clean water). The goal of the program is to promote a broader acceptance of the principles of montane forest conservation among rural Ecuadorians, many of them landowners themselves. In addition, CFTC has promoted El Pahuma as a site for scientific research and has attracted biologists studying such topics as orchid microclimate requirements, floral morphology of Gesneriads, and bat pollination syndromes.

To date, the conservation easement at the El Pahuma Orchid Reserve has achieved the protection of montane forest habitat and set the stage for an improved standard of living for the landowner and his family. The incentives offered provided an opportunity for positive feedback: by early 2004, the reserve was attracting ca. 1000 visitors per month. The income derived from ecotourism has eliminated economic pressure on the landowner to exploit or convert the forest. El Pahuma's success serves as a model for conservation on other private lands. Nevertheless, the specific incentives that were effective for El Pahuma may not be appropriate in other cases, for example, where tourism potential is low; in such cases, alternative incentives must be developed that fit local needs. The success of El Pahuma largely hinged on the heartfelt interest of the landowner in conservation, and we view such interest by the landowner as a key to the positive outcome of any private land conservation effort.

CONCLUSIONS

Private lands hold promise for conservation, particularly for restricted-range species in the Andes, where the vast majority of threatened and endemic taxa, such as orchids, are unprotected. Several legal mechanisms exist for conservation on private lands, and conservation easements, in particular, represent a flexible and inexpensive tool that is gaining acceptance throughout Latin America. Organizations implementing easements on private lands need to consider not only the biological value of the site but the socioeconomic context of the landowner as well, and design incentives accordingly. The El Pahuma Orchid Reserve in Ecuador represents an example of how an easement can be implemented to protect habitat and enhance the lives of local people. Like any conservation mechanism, long-term success requires that human and financial resources be dedicated to monitoring and, if necessary, to remedial action or litigation. Although development of suitable incentives remains a challenge for successful conservation on private lands, organizations can view this as an opportunity rather than a hindrance. Thus we urge the funding community to dedicate resources to support conservation on private lands. Rapid action is needed not only in the Andean region but also in tropical dry forests, mangroves, and other areas where remaining biodiversity faces an uncertain fate in dwindling remnants of unprotected habitat.

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